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ABSTRACT

In addition to componential aspects of verb meaning, children must also acquire a representation of each verb's combinatorial properties or propositional schema, i.e., the number of arguments with which it is obligatorily or optionally associated. The present study investigated developmental changes in children's awareness of the combinatorial requirements of 22 early learned verbs, through their judgements and corrections of sentences from which obligatory and optional arguments had been omitted. Twenty-five children in each of three age groups (mean ages: 4;4, 7;2, and 10;0) were asked to judge and correct 44 sentences constructed to contrast verb pairs for which the same argument was obligatory or optional. Results showed significant changes across age groups in awareness of verb argument requirements, with this apparent progression: (1) initial ignorance of argument requirements, (2) gradually increasing awareness of these requirements, (3) overgeneralization of requirements to sentences lacking optional arguments, and (4) an adult-like representation of obligatory and optional arguments for each verb. (Author)

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THE ACQUISITION OF VERB PROPOSITIONAL SCHEMATA

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Introduction

Despite increasing awareness of the importance of verbs as a form class of words, the acquisition of adultlike lexical entries for individual verbs has only relatively recently become a focus of attention in child language research. Some of the reasons for this lack of information are methodological, one of the most obvious being the difficulty of representing dynamic events through static pictures and the expense of filmed or computer-generated alternatives. An additional and more fundamental obstacle to the study of verb acquisition, however, is epistemological in origin. Specifically, there is no single, tidy framework uniting the multitude of phenomena related to the role of verbs in the linguistic systems of either adults or children.

If we oversimplify matters greatly, it is possible to discern two complementary emphases in attempts to analyze verb meaning. The first, which might be termed a "componential" or "definitional" (Fodor, Garrett, Walker, and Parkes, 1980) emphasis, has involved internal lexical analyses of the meanings of individual verbs, yielding sets of presumably more primitive meaning components. The componential approach is thus similar in many respects to semantic feature analyses of noun meanings (Clark, 1973) and has been used in a number of investigations of child language acquisition (Bowerman, 1978; Gentner, 1978, 1981).

The peculiar "relational" properties of most verbs are not addressed from a componential perspective, however. That is, in

addition to componential aspects of verb meaning, children must also acquire a representation of what might be called each verb's "combinatorial" properties--the number of arguments, or entities, with which the verb is obligatorily or optionally associated.

Predicate calculus analyses of predicate and sentence meaning explicitly address this issue, and classify predicates according to the number of arguments upon which they operate. "Sleep," for example, is a one-argument predicate, since it attributes a property to a single entity (or case role). "Hit," on the other hand, describes a relationship between two entities; it is thus identified as a two-argument predicate.

A predicate with its associated arguments is known as a "proposition," which is viewed as a natural unit of meaning in many semantic accounts (Clark and Clark, 1977). Both individual predicates and entire sentences can be analyzed into propositional schemata, consisting of the predicate and its arguments. This fact highlights the influence of predicate meaning on sentence structure, for choice of a predicate, according to this view, entails choice of that predicate's propositional framework or schema as well. Thus, construction of sentences using that predicate must take place within the constraints imposed by its propositional schema or argument structure.

Predicates are not isomorphic with verbs; in fact, verbs as a syntactic class constitute a subcategory of predicates. However, the idea of classifying predicates according to the number of arguments with which they are associated is related to the

traditional linguistic concept of verb valency, which is in turn related to notions of transitivity and government (Hopper and Thompson, 1980). The valency of a verb can be summarized by the number of arguments it requires: one-argument verbs are monovalent; two-argument verbs are bivalent, and so on (Lyons, 1977). Similarly, the notion of transitivity has traditionally been used to distinguish between those verbs which require a direct object (transitive verbs) and those which do not (intransitive verbs).

An unresolved problem in combinatorial analyses of verb meaning, whether logically or linguistically motivated, involves the number of arguments "associated" with a given verb. How are these arguments to be identified? Most predicate-argument frameworks used in logical analysis have relied on the distinction between obligatory and optional arguments of predicates in well-formed formulae, since well-formedness is defined by the rules of the propositional calculus, obligatory arguments are simply identified according to those rules. However, although theorists using predicate-calculus systems for linguistic (rather than logical) analysis have also relied implicitly on the distinction between obligatory and optional arguments, the criteria for distinguishing between the two in natural language are much less straightforward.

Fillmore (1971) distinguished between two levels at which an argument could be said to be required by a predicate in natural language: the surface structure level and the conceptual

level. At the surface structure level, omission of an obligatory argument results in an ungrammatical string, but surface structure grammaticality is not a reliable guide to whether an argument is conceptually or logically required, nor does the conceptual structure predict the surface structure requirements. There are some verbs requiring two arguments at the conceptual level which require only one argument at the surface structure level; there are other verbs for which deletion of a conceptually-required argument at the surface structure level results in an ungrammatical sentence.

There is no easily discernible rule which can be used to predict whether an argument will be obligatory or optional at the surface structure level for a given verb. Compare, for example, sentences containing the verbs "drink" and "carry." Both of these verbs require two arguments at the conceptual level. However, while omission of the object argument from a surface structure with the former verb results in a grammatical sentence ("She is drinking"), the opposite outcome results with the latter verb: *"She is carrying" is not typically judged to be a grammatical sentence by adult speakers of English. Similar examples can be found even for pairs of verbs which otherwise share many semantic components, such as "leave" ("She is leaving the keys") and "set" (*"She is setting the keys").

Learning the arguments required by verbs at the level of surface structure would appear to be a complex and important task: Complex, because it must be accomplished on a verb-by-verb basis,

without benefit of rules of generalizations; and important, because of the influence of verb propositional schemata on the syntactic scaffolding of sentences and their grammaticality. Descriptions of child language contain many examples of utterances which are deviant by virtue of obligatory argument omission, and part of the child's developing semantic-syntactic skill involves a refinement of verb lexical entries to establish the obligatory and optional links between individual verbs and their arguments (Lord, 1979). The present study examined the developmental progression in this process over the age range from four to ten years, for a set of twenty-two early-learned verbs, by asking children to judge and correct sentences which met or failed to meet the surface structure combinatorial requirements of their verbs.

Methods

Subjects

The subjects in the study were seventy-five normal, monolingual English-speaking children. There were twenty-five children in each of three age groups, with mean chronological ages of 4;6 (henceforth the "four-year-olds"), 7;3 (the "seven-year-olds"), and 10;0 (the "ten-year-olds").

Stimulus sentences

Stimulus sentences were constructed by dividing a set of twenty-two frequently-occurring and early-appearing verbs into

pairs, such that the same argument was obligatory for one verb but optional for the other at the level of surface structure. The verb pairs and their surface structure propositional schemata are found in Table 1. Decisions about the obligatoriness or optionality of arguments for most of these verbs were made on the basis of the acceptability judgments of fifteen adults; decisions for the remaining verbs were made by the investigator after it was ascertained that her judgments were in agreement with those of the adult subjects.

Members of each verb pair were placed in identical syntactic frames, two of which contained the argument in question and were acceptable by adult standards. These two sentence types can be labeled "Obligatory + Present" and "Optional + Present," indicating the status of the argument for the sentence verb (obligatory or optional) and the presence of the argument in the surface structure of the sentence. (See Table 2.)

The other two identical syntactic frames were sentences from which the same argument had been omitted. For one of these sentence types ("Obligatory + Absent") the argument was obligatory at the level of surface structure; since it was omitted, this type of sentence was unacceptable by adult standards. For the other member of these sentence pairs ("Optional + Absent"), the missing argument was optional at the level of surface structure; these sentences were therefore acceptable by adult standards. (See Table 2.)

Each pair of verbs thus yielded four sentences, three of which were acceptable by adult standards (Obligatory + Present, Optional + Present, and Optional + Absent) and one of which was deviant by adult standards (Obligatory + Absent), for a total of forty-four stimulus sentences. (See Table 3.)

Procedures

Each subject was interviewed individually by the same examiner, who first trained subjects to make judgments and corrections of sentences on the basis of semantic anomaly rather than deviance due to the absence of an obligatory argument. After completion of four practice sentences (see Table 3) the examiner read the randomly-ordered stimulus sentences to the subject, who judged each sentence as either "sounding okay" or "not sounding okay." These judgments comprised the set of judgment data. If the subject judged a sentence to be unacceptable, he or she was immediately instructed to "fix" the sentence "so that it sounds okay," yielding the set of correction data. Subsequent to the judgment/correction task each subject also completed a picture-pointing comprehension test designed to ensure that he or she already had a representation of at least the main componential aspects of each verb's meaning in his or her lexicon.

Scoring

A. Judgment data

Children's judgments of the sentences were scored as being either adultlike or nonadultlike. The adultlike judgment for

TABLE 1. VERB PAIRS AND PROPOSITIONAL SCHEMATA*

GIVE	(Agent, Object, Recipient)
TAKE	(Agent, Object) /Recipient/
SET	(Agent, Object, Location)
LEAVE	(Agent, Object) /Location/
MAKE	(Agent, Object)
DRAW	(Agent) /Object/
HOLD	(Agent, Object)
EAT	(Agent) /Object/
CARRY	(Agent, Object)
DRINK	(Agent) /Object/
CHASE	(Agent, Object)
RIDE	(Agent) /Object/
STIR	(Agent, Object)
COOK	(Agent) /Object/
FIX	(Agent, Object)
READ	(Agent) /Object/
BUILD	(Agent, Object)
PAINT	(Agent) /Object/
WEAR	(Agent, Object)
SEW	(Agent) /Object/
CATCH	(Agent, Object)
WATCH	(Agent) /Object/

*(Obligatory arguments)
/Optional arguments/

TABLE 2. EXAMPLES OF THE FOUR SENTENCE TYPES*

Type	Example
Obligatory + Present	The boy is making a picture.
Optional + Present	The boy is drawing a picture.
Obligatory + Absent	*The boy is making.
Optional + Absent	The boy is drawing.

*Deviant sentence

TABLE 3. STIMULUS SENTENCES

Note: 1 = Obligatory + Present
2 = Optional + Present
3 = Obligatory + Absent
4 = Optional + Absent

1. The girl is giving the box to the boy.
2. The girl is taking the box to the boy.
3. *The girl is giving the box.
4. The girl is taking the box.

1. The boy is setting the keys on the table.
2. The boy is leaving the keys on the table.
3. *The boy is setting the keys.
4. The boy is leaving the keys.

1. The boy is making a picture.
2. The boy is drawing a picture.
3. *The boy is making.
4. The boy is drawing.

1. The boy is holding a banana.
2. The boy is eating a banana.
3. *The boy is holding.
4. The boy is eating.

1. The girl is carrying some milk.
2. The girl is drinking some milk.
3. *The girl is carrying.
4. The girl is drinking.

1. The girl is chasing the horse.
2. The girl is riding the horse.
3. *The girl is chasing.
4. The girl is riding.

1. The boy is stirring the soup.
2. The boy is cooking the soup.
3. *The boy is stirring.
4. The boy is cooking

1. The boy is fixing the book.
2. The boy is reading the book.
3. *The boy is fixing.
4. The boy is reading.

TABLE 3. STIMULUS SENTENCES (CONT)

1. The girl is building a tower.
2. The girl is painting a tower.
3. *The girl is building.
4. The girl is painting.

1. The girl is wearing a shirt.
2. The girl is sewing a shirt.
3. *The girl is wearing.
4. The girl is sewing.

1. The girl is catching a bird.
2. The girl is watching a bird.
3. *The girl is catching.
4. The girl is watching.

PRACTICE SENTENCES

The dog ran away.
The carrot jumped up.
The boy fell down.
The tree walked away.

Obligatory + Present, Optional + Present, and Optional + Absent sentences was an acceptance ("okay"); the adultlike judgment for the deviant Obligatory + Absent sentences was a rejection ("not okay').

B. Correction data

The number of potential kinds of corrections is obviously vast, but not all corrections provided information which was strong enough to support inferences about children's understanding of verb argument requirements. Corrections were initially sorted into three general categories on the basis of the kind and strength of the evidence which they provided:

1. Propositional Corrections consisted of direct modifications of the propositional schema of the stimulus sentence, and thus provided strong evidence that children had identified the propositional schema of the sentence as the source of its unacceptability. Two kinds of Propositional Correction were observed. In one, the verb of the stimulus sentence was maintained and a semantically appropriate argument was inserted in the empty argument slot (e.g., *The boy is fixing--The boy is fixing the bike). In the other, the verb of the stimulus sentence was replaced by a verb of decreased valency, for which the missing argument was no longer obligatory, thus effectively eliminating the empty argument slot (e.g., *The boy is fixing--The boy is eating).

2. Nonpropositional Corrections provided strong evidence that children had not identified argument omission as the source of the sentence's deviance, but were rather rejecting it for some other reason. For example, a child might merely substitute a different argument for one of the arguments of the stimulus sentence (e.g., *The boy is stirring--*The mom is stirring). Alternatively, the child might maintain the verb and arguments of the stimulus sentence but alter it by negation or addition of a clause unrelated to the empty argument slot (e.g., *The boy is fixing--*The boy is fixing because he wants to; *The boy is fixing--*The boy is not fixing).

3. Unclear Corrections did not provide strong evidence for either of the above interpretations, and consisted of either corrections in which the child failed to maintain either the verb or at least one of the arguments present in the stimulus sentence (e.g., *The boy is fixing--The girl laughed), or corrections which otherwise altered the sentence in ways which made it difficult to determine whether or not the propositional schema was viewed as the source of the sentence's deviance.

Results

Judgment data

The mean number of adultlike judgments for each of the four sentence types (Obligatory + Present, Optional + Present, Obligatory + Absent, and Optional + Absent) was computed for each of

the three age groups; these data are best presented in graphic form.

Looking first at children's judgments of Obligatory + Present and Optional + Present sentence types (Figure 1), we see that although the number of adultlike judgments does increase with increasing age, judgments of these two sentence types change in very similar ways.

There was a much greater change with age in children's judgments of Obligatory + Absent sentences (those deviant by adult standards). As shown in Figure 2, there was a significant increase in the number of adultlike judgments of these sentences, suggesting a gradually increasing awareness of the surface structure argument requirements of these verbs.

A surprising result emerged in the data on Optional + Absent sentences (acceptable by adult standards), as shown in Figure 3. Four-year-olds and seven-year-olds judged these sentences as being similar in acceptability to Obligatory + Present and Optional + Present sentences. However, the ten-year-olds judged Optional + Absent sentences to be unacceptable significantly more often than the younger groups. Their judgments of Optional + Absent sentences thus actually became <u>less</u> adultlike with age--in direct contrast to the consistent increase with age in adultlike judgments of Obligatory + Absent sentences.

Overgeneralization or overregularization would appear to provide a reasonable interpretation of this apparent regression in performance on judgments of Optional + Absent sentences. The

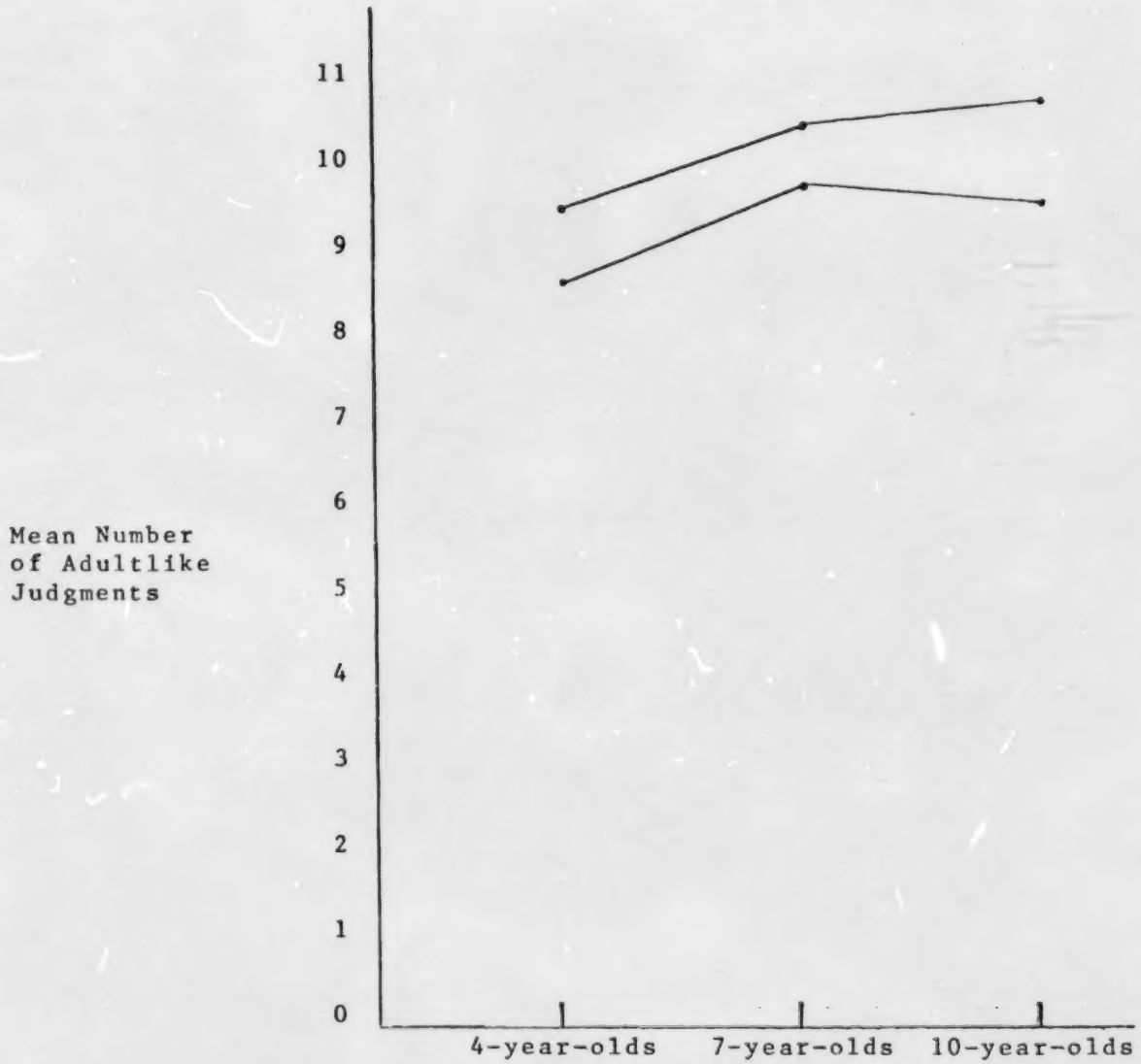

Fig. 1. Mean number of adultlike judgments of OBLIGATORY + PRESENT (1) and OPTIONAL + PRESENT (2) sentences.

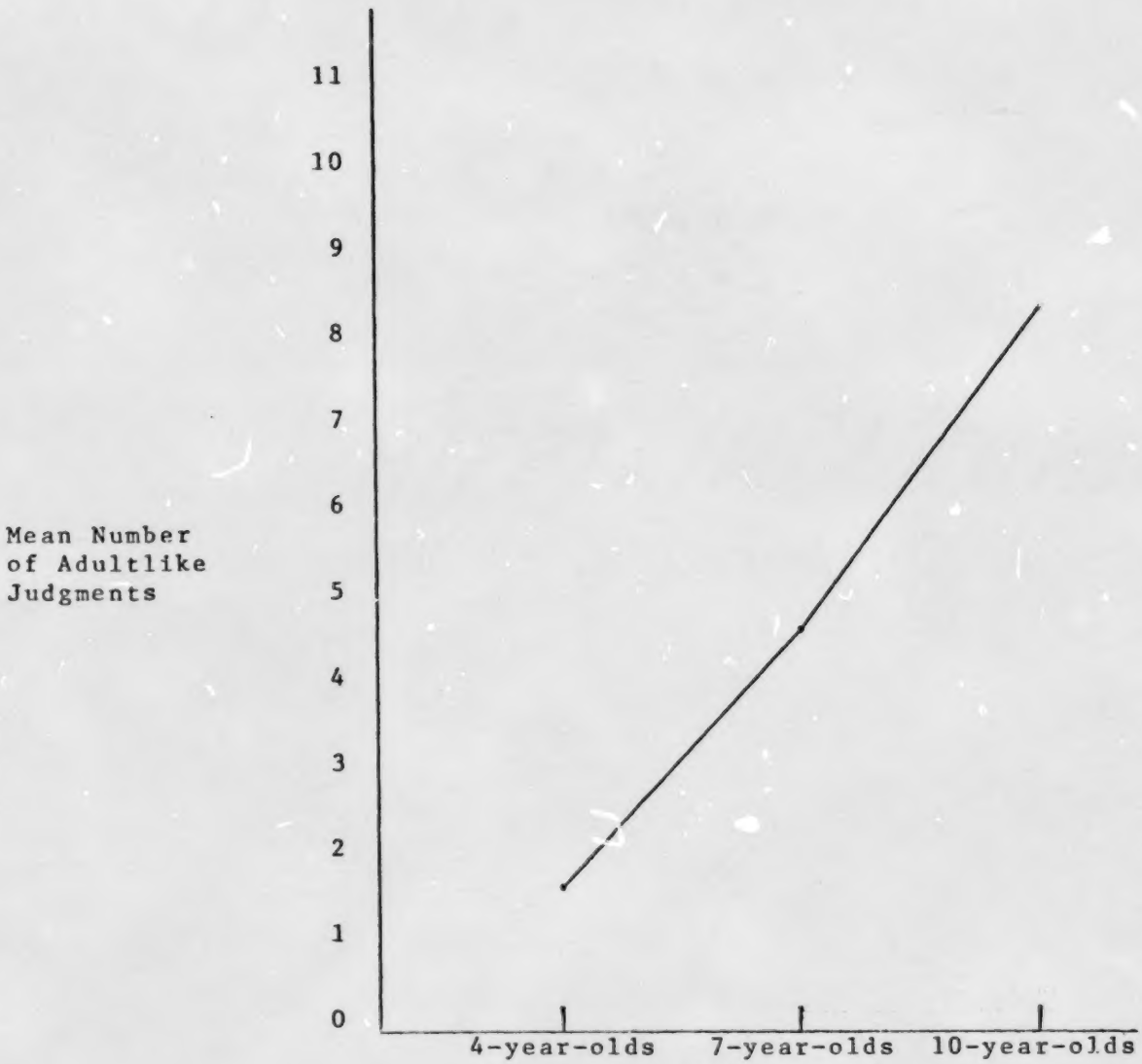

Fig. 2. Mean number of adultlike judgments of OBLIGATORY + ABSENT Sentences

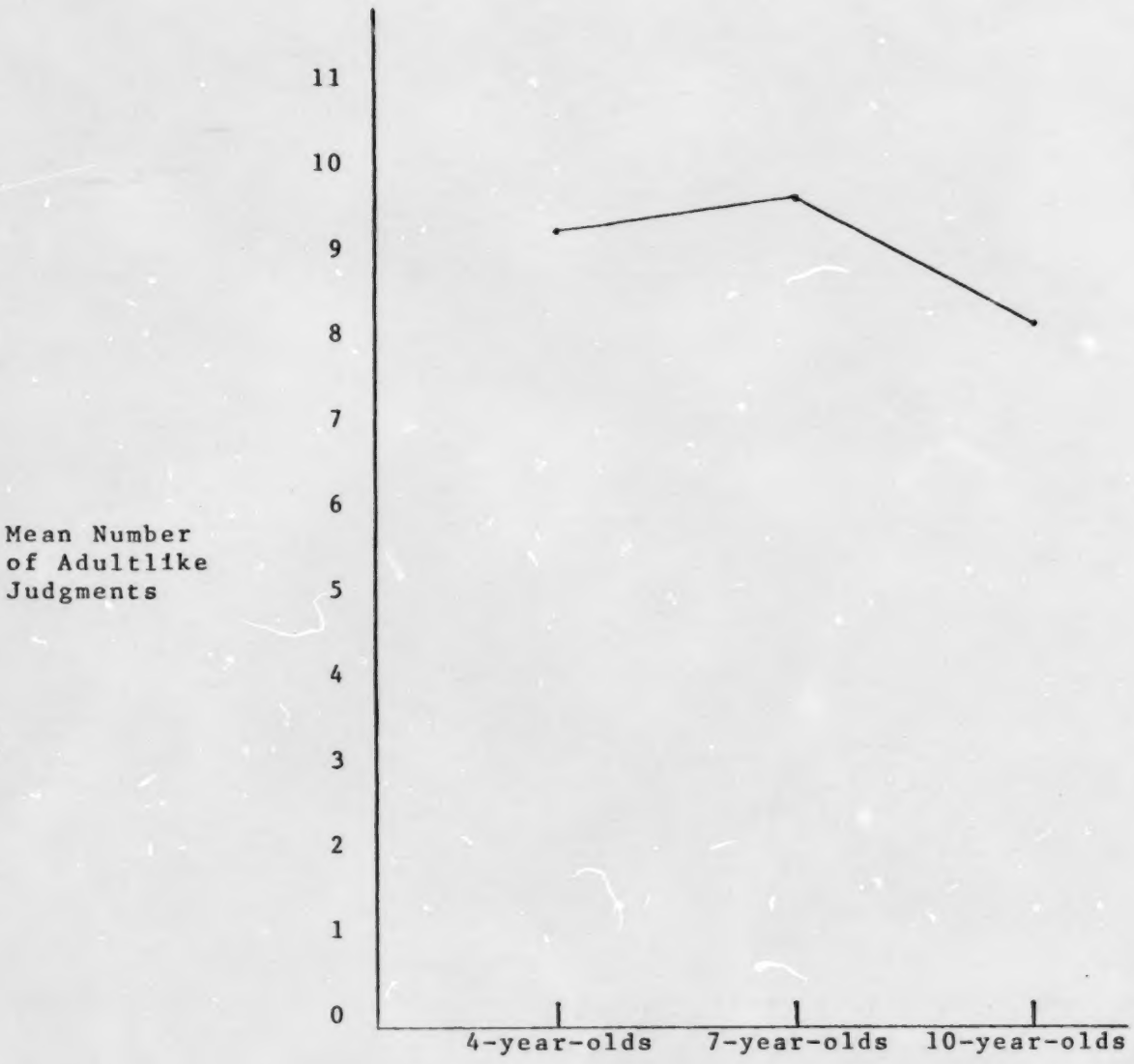

Fig. 3. Mean number of adultlike judgments of OPTIONAL + ABSENT sentences.

findings for Obligatory + Absent sentences suggest that over the age range from four to ten years, children are gradually learning that some verb arguments are obligatory in surface structure; the findings for Optional + Absent sentences suggest that the ten-year-olds have incorrectly concluded that all such arguments are obligatory. Thus, in addition to correctly rejecting the deviant Obligatory + Absent sentences, they incorrectly rejected the acceptable Optional + Absent sentences.

Correction data

The correction data showed that the proportion of Unclear Corrections (those not interpretable as either propositional or nonpropositional modifications) decreased with increasing age (Table 4). This finding is probably related to both an increase in awareness of the propositional requirements of sentence verbs and the increasingly evident ability of children to tie their corrections directly to the surface structure of the stimulus sentence.

When the Unclear Corrections were excluded in order to allow comparison of the age-related changes in proportions of Propositional and Nonpropositional Corrections (Table 5), it was found that 90% of the corrections of Obligatory + Present and Optional + Present sentences altered some aspect of the sentence other than its propositional schema. For Obligatory + Absent and Optional + Absent sentences, however, there was a consistent increase with age in the proportion of Propositional Corrections

TABLE 4. FREQUENCIES (AND PROPORTIONS) OF PROPOSITIONAL, NONPROPOSITIONAL, AND UNCLEAR CORRECTIONS

Age Group / Correction Type	4-year-olds		7-year-olds		10-year-olds	
Propositional	41	(.20)	136	(.77)	275	(.92)
Nonpropositional	59	(.29)	21	(.12)	13	(.04)
Unclear	103	(.51)	19	(.11)	11	(.04)

TABLE 5. PROPORTIONS OF PROPOSITIONAL CORRECTIONS OF THE FOUR SENTENCE TYPES*

Age Group / Sentence Type	4-year-olds	7-year-olds	10-year-olds
Obligatory + Present	.10	.10	.09
Optional + Present	.06	0	0
Obligatory + Absent	.68	.98	1.00
Optional + Absent	.28	.91	.98

*Excluding Unclear Corrections

which directly modified the sentence propositional schema. This pattern of correction results provides further support for the conclusion from the judgment data, that there are developmental changes in children's awareness of the surface structure propositional requirements of these verbs.

The correction data also provide evidence supporting the overgeneralization interpretation which was proposed as a possible explanation for the decrease in number of adultlike judgments of Optional + Absent sentences by the oldest subjects. When the four-year-olds did reject Optional + Absent sentences, 72% of their corrections were addressed to some aspect of the sentences other than their propositional schemata, suggesting that the perceived source of deviance was something other than the missing optional argument. In contrast, over 90% of the ten-year-olds' corrections of Optional + Absent sentences consisted of modifications of their propositional schemata--supporting the inference that they had incorrectly overextended their knowledge of the obligatoriness of Obligatory + Absent sentence arguments to the optional arguments of Optional + Absent sentences.

Because of the fact that 51% of the corrections produced by the four-year-olds were Unclear Corrections, this correction type was further scrutinized, and one pattern was found to occur with some frequency. In these cases, children's corrections were specifically aimed at "correcting" the state of affairs described by the stimulus sentence, rather than any aspects of its surface structure. Many of the four-year-olds' corrections appeared to

be based on their evaluation of the likelihood or desirability of the situation described by the stimulus sentence; their corrections reflected attempts to verbally improve situations which they apparently viewed as unfortunate or improbable. For example, for the stimulus sentence "The boy is leaving the keys on the table," many of the four-year-olds' corrections suggested that they were imagining a better way for the boy to act: "Instead of leave 'em, put 'em in the closet where the hook is" (Subject 14), or "The boy is hanging 'em" (Subject 7). Or, in even greater detail, "He has to bring 'em to school, in case the door is locked, he can open the door with the keys" (Subject 32).

It is important to note that the negative consequences of "leaving the keys" were nowhere conveyed in the stimulus sentence--the children were inferring a specific set of negative outcomes from some general and neutral sentences, suggesting perhaps that their most salient or memorable, or possibly initial (Schank and Abelson, 1977) experiences with "leaving the keys" had occurred in the context of undesirable results. The tendency to correct the situation described by the stimulus sentence was not limited to the event of "leaving the keys," however. Other stimulus sentences also referred to activities which four-year-olds apparently viewed as dangerous, forbidden, and/or inappropriate because of the gender or age of the Agent. A delightful example was provided by one of the three-year-old subjects in response to the stimulus sentence "The girl is chasing": "I don't know what she's chasing. If she was chasing a bear, she would get hurt, and that's not okay."

The tendency for young children to respond to linguistic stimuli primarily on the basis of semantic rather than syntactic considerations has been widely noted in the child language literature (Berthoud-Papandropoulou, 1978). The fact that it occurred in the present study should not overshadow the fact that 83% of the four-year-olds' corrections were at least partially related to the stimulus sentence in that its verb or one of its arguments was maintained in the correction. Totally unrelated corrections, in addition to being infrequent, were much more narrowly distributed among subjects--just four subjects produced over 80% of the unrelated corrections. For each of these four subjects, their corrections were almost stereotypic, regardless of the stimulus sentence; they were in fact strongly reminiscent of Adam's legendary reply to Brown, Fraser and Bellugi's (1964) query about a point of grammatical structure: "Pop goes the weasel."

Conclusions

The results of both the judgment and correction tasks used in this study support the conclusion that there are developmental changes in children's representations of the surface structure propositional schemata of this set of verbs. The data also show that this process is not complete at age ten.

The results also provide evidence that in the course of learning that some arguments are obligatory, some children may temporarily make the incorrect assumption that all arguments are obligatory, prior to learning that verb combinatorial requirements

are actually lexically-specific rather than rule-governed. These conclusions are supported by data from both children's judgments and their corrections of sentences they judged to be deviant. The correction data further revealed age-related increases in attention to and successful manipulation of the surface structure characteristics of sentences.

Implications for Future Research

The findings from this study suggest a number of possibilities for future research. One set of questions concerns the relationship between children's judgments and corrections of propositional schemata and their utilization of these schemata in production and comprehension tesks. It seems reasonable to speculate that knowing a verb's propositional schema might facilitate the processing of sentences containing that verb. For example, it might be easier to produce sentences containing only obligatory arguments than to produce sentences of equal length which contain some optional arguments. If knowledge of verb propositional schemata does have such an influence, it would suggest that exploration of the effects of verb choice on production of spontaneous and elicited utterances might provide further refinement of our global notions of what constitutes semantic-syntactic complexity. Similarly, comprehension of sentences might also be affected by knowledge of the propositional schema of the sentence verb, particularly in less-than-ideal conditions when more than the usual amount of inferencing is required in order to arrive at a complete understanding of the sentence meaning.

Another general topic awaiting future investigation is the development of awareness of conceptual level propositional requirements of various verbs. The data from this study support the inference that children develop an awareness of conceptual level verb argument requirements prior to surface structure level requirements, but there remain numerous questions regarding the way in which a verb comes to be inextricably associated with a set of arguments at the conceptual level. It seems logical to suppose that, like noun meanings, verb meanings may initially be tied to very specific instantiations of argument slots, and that the range of potential occupants for these slots is gradually delimited, but there is as yet very little evidence on this point.

Another question evolving from the data of this study is simultaneously one of the most fundamental and most intriguing: How do children ever unravel the lexically-specific propositional requirements at the level of surface structure? Clearly this learning process is not a simple one; it is a difficult and lengthy task to sort out the apparent idiosyncracies of verb argument requirements, as this study has shown. One possibility worthy of future attention is that although none have yet been discovered, there may nonetheless be some systematic factors which determine whether arguments are obligatory or optional for their verbs at the level of surface structure. It seems likely that further exploration of the relationship between verb meanings and referent states or events will be necessary in order to determine whether or not these factors exist. For example, the closeness of the

link between a verb and its argument--i.e., the predictability of a particular argument given a particular verb--is a logical candidate for such a factor. Perhaps arguments which are more predictable at the conceptual level also tend to be more superfluous at the level of surface structure.

Finally, the results of this study have demonstrated the viability of the judgment/correction paradigm as a tool in child language research. The majority of even the youngest children's corrections maintained at least one of the contentives of the propositional schema of the stimulus sentence, and even the youngest subjects were quite willing to contemplate and revise the sentences in terms of whether they found them to be "okay" or "not okay." It would seem, then, that judgment and corrections tasks can be a very efficient means of probing the developing language systems of children as young as three years of age, when the phenomena of interest are sufficiently well-specified and controlled.

Implications for the Classroom

The idea that "knowing" a particular verb requires knowledge of its combinatorial or propositional schema has some obvious implications for the manner in which new verbs are taught. This aspect of verb meaning will be most readily acquired if the verb is introduced within the syntactic frame composed of its obligatory arguments; introducing the verb in isolation, or embedded in only a fragment of its obligatory schema would fail to provide the language learner with the necessary lexically-specific experience

which would allow rapid, accurate construction of the obligatory argument structure for the verb.

In addition, the judgment/correction paradigm used in the present study warrants further consideration from educators as a potentially efficient and effective means of gathering information on children's level of performance for specific linguistic constructions. By separating children's awareness of the acceptability of a particular language structure from their ability to use the structure correctly in comprehension or production tasks, teachers can better pinpoint the source or level of a child's language difficulty and provide information specifically tailored to assisting the child in deducing the correct rule.

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